European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.546618

Volume 3 | Issue 5 | 2017

DEVELOPMENT OF AN INNOVATIVE INSTRUCTIONAL STRATEGIES COMBINED WITH THE STEM EDUCATION AND BRAINSTORMING TECHNIQUES FOR ENHANCING STUDENTS' LEARNING ACHIEVEMENTS AND TRANSFORMING THEIR SCIENCE RELATED ATTITUDES AT THE 8TH GRADE LEVEL

Varangkul Watthananusit[1],
Toansakul Santiboon[2i],
Natchanok Jansawang[3]
[1,2]Department of Science Education, Faculty of Education
Rajabhat Maha Sarakham University, Maha Sarakham, Thailand 44000
[3]Department of Physics, Faculty of Science and Technology
Rajabhat Maha Sarakham University, Maha Sarakham, Thailand 44000

Abstract:

The purposes of this research were to evaluate and develop of *An Innovative Instructional STEM Education Strategy Lesson Plan Combined with the Brainstorming Techniques* (STEM & BTS) for enhancing students' learning achievements and transforming their science related attitudes for secondary students at the 8th grade level in science class on Light and Visible Light issue with the processing and performance resulting effective determinant criteria at the level of 75/75. Students' learning achievements and their science attitudes to their pre and post assessing designs toward their learning management according to the instructional model of learning management in the STEM & BTS were compared. Associations between students' learning achievements of their posttest assessment and their attitudes toward science with the STEM & BTS for enhancing students' learning achievements and transforming their science related attitudes were assessed. Administration of the sample size of 25 students at the 8th grade level from Khatiyawongsa School under the Secondary Educational Service Area Office 27, Roi-Et with the purposive random sampling technique was selected. The STEM & BTS composed of an innovative instructional lesson plan and 9 subunits in 15 hours on 5 weeks were instructed management. Students' learning achievements were assessed with the 50-item *Learning Achievement* Test (LAT) in four multiple choices of their pretest and posttest assessments. Students'

[i] Correspondence: jackjackjockjock24@gmail.com, toansakul35@yahoo.com.au

attitudes toward science were assessed of their perceptions with the 8-item *Test Of Science-Related Attitude* (TOSRA). Statistically significant was analyzed the data with Mean $(\overline{X})$, Standard Deviation (S.D.), Percentage, t-test, One-Way ANOVA (eta^2), Simple Correlation (r), Standardized Regression Coefficient (β), Multiple Correlation (R), and Coefficient Predictive Value (R^2). The results of these research findings followed as: An innovative instructional STEM education strategy combined with the brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes at the 8th grade level was assessed of six learning activities by the 3-Professional Experts with the *Index of Item Objective Congruence* (IOC), it has found that the IOC indicated of 0.88, students' responses of their learning activities were at the high level, the relationships of six learning activities with F-test was significant at level of 0.001, and the Cronbach Alpha Reliability of the TOSRA was 0.79. The effectiveness of the innovative learning management lesson plan in form of the STEM & BTS (E1/E2) was 77.64/78.48, which has higher than the standardized determining criteria of 75/75. Students' learning achievements of their pretest and posttest assessments with the LAT to the STEM & BTS with their posttest was higher than pretest and statistically significant was differentiated, significantly ($p < .001$). Students' attitudes toward science were assessed with the TOSRA, the average mean scores with their post-attitude were higher than pre-attitude and statistically significant was differentiated, significantly ($p < .01$). Associations between students' learning achievements of their post-LAT their post-TOSRA toward science, the R^2 value indicated that 50% of the variance in students' learning achievements of their science class was attributable to their post attitudes toward science in the STEM & BTS for enhancing students' learning achievements and transforming their science related attitudes and statistically significant was also found at the 0.01 level, relatively.

Keywords: development, an innovative instruction, STEM education, strategy, brainstorming techniques, enhancement, students' learning achievements, transformation, science related attitudes

1. Introduction

Education is a light that shows the mankind the right direction to surge. The purpose of education is not just making a student literate but adds rationale thinking, knowledge ability and self-sufficiency. When there is a willingness to change, there is hope for progress in any field. Creativity can be developed and innovation benefits both students and teachers (Damodharan, 2014). An instructional model represents the broadest level of instructional practices and presents a philosophical orientation to instruction. Models are used to select and to structure teaching strategies, methods, skills, and student activities for a particular instructional emphasis. Instructional models are related to theories about how student learn. Some examples include: behaviorism, cognitivism, constructivism, and connectivism. Various learning theories fit within these general categories, i.e., adult learning theory, transformative learning, social interaction, motivation theory, etc. Within each model, several strategies can be used. Strategies determine the approach a teacher may take to achieve learning objectives. Strategies can be classed as direct, indirect, interactive, experiential, or independent. Instructional methods are used by teachers to create learning environments and to specify the nature of the activity in which the teacher and learner will be involved during the lesson. While particular methods are often associated with certain strategies, some methods may be found within a variety of strategies. (Keesee, 2015). Capable instructors are aware of the principle of active learner participation. Given the choice between two techniques, choose the one involving the learners in the most active participation (Knowles, 1984).

Evaluation of teaching can have many purposes, including collecting feedback for teaching improvement, developing a portfolio for job applications, or gathering data as part of personnel decisions, such as reappointment or promotion and tenure. Most of the methods can be used for all of these functions. In general, efforts to collect information for improvement can be informal and focus on specific areas an individual instructor wishes to develop. Information for job applications involves presenting one's best work and meeting the requirements outlined in job ads. However, when the purpose of evaluation is personnel decision making, it is important to use a comprehensive and systematic process. What follows are multiple methods for collecting information about instructors' activities, accomplishments, and effectiveness in teaching, in the classroom and beyond. While this list includes best practices for using student ratings, it also offers suggestions for ensuring that student ratings are not the only source of evidence used to assess instructional effectiveness, an approach consistent with research. In addition, detailed resources are available on the topics of student ratings of instruction, peer review of teaching, course portfolios, and teaching portfolios (Central of Research on Teaching and Learning, 2015).

Provides nearly 4,000 science, technology, engineering and math resources for PreK-5, 6-12 as well as free, self-paced modules for teachers teaching global climate change to middle school and high school students are instructional designs. Instructional design, or instructional systems design (ISD), is the practice of creating "*instructional experiences which make the acquisition of knowledge and skill more efficient, effective, and appealing*" (Merrill, Drake, Lacy, and Pratt, 1996). The process consists broadly of determining the state and needs of the learner, defining the end goal of instruction, and creating some "intervention" to assist in the transition. The outcome of this instruction may be directly observable and scientifically measured or completely hidden and assumed (Mayer, 1992). The Science, Technology, Engineering and Mathematics (STEM, previously SMET) are a term that refers to the academic disciplines of science, technology, engineering and mathematics (New Jersey Technology and Engineering Educator Association, 2015).

Students are extremely curious and impressionable, so instilling an interest at an early age could spark a lasting desire to pursue a career in any of these fields. By the time a student is ready to enter the work force, they must have enough knowledge to make invaluable contributions to our nation's STEM education. It is also important that schools have an ample amount of teachers who are experts in STEM, and these subjects should always be considered as high demand subjects. Student learning outcome performances clearly state the expected knowledge, skills, attitudes, competencies, and habits of mind that students are expected to acquire at an institution of higher education. Transparent student learning outcomes statements are; specific to institutional level and/or content level, clearly expressed and understandable by multiple audiences, prominently posted at or linked to multiple places across the other context, to be updated regularly to reflect current outcomes, and to be receptive to feedback or comments on the quality and utility of the information provided. In this research study, using the instructional management between STEM education method for developing students' learning achievements and developing this instructional model for enhancing students' learning achievements and transforming their science related attitudes of secondary students at the 8th grade level in science class was designed.

Brainstorming is a group creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its members. The term was popularized by Alex Faickney Osborn in the 1953 book Applied Imagination. Advertising executive, he began developing methods for creative problem-solving in 1939. He was frustrated by employees' inability to develop creative ideas individually for ad campaigns. In response, he began hosting group-thinking sessions and discovered a significant improvement in the quality and quantity of ideas produced by employees. Osborn outlined his method in the 1948 book *Your Creative Power* in chapter 33, "*How to Organize a Squad to Create Ideas*" (Osborn, 1963). These principles were his four general rules of brainstorming, established with intention to: reduce social inhibitions among group members, stimulate idea generation, and increase overall creativity of the group on four steps: *Go for quantity*; this rule is a means of enhancing divergent production, aiming to facilitate problem solving through the maxim *quantity breeds quality*. The assumption is that the greater the numbers of ideas generate the bigger the chance of producing a radical and effective solution. *Withhold criticism*; in brainstorming, criticism of ideas generated should be put 'on hold'. Instead, participants should focus on extending or adding to ideas, reserving criticism for a later 'critical stage' of the process. By suspending judgment, participants will feel free to generate unusual ideas. *Welcome wild ideas*; to get a good long list of suggestions, wild ideas are encouraged; they can be generated by looking from new perspectives and suspending assumptions. These new ways of thinking might give you better solutions, and *Combine and improve ideas*; as suggested by the slogan "1+1=3". It is believed to stimulate the building of ideas by a process of association (Furnham, & Yazdanpanahi, 1995). This research study was to separate each student in a circular group writes down one idea, and then passes the piece of paper to the next person, who adds some thoughts. This continues until everybody gets his or her original piece of paper back. By this time, it is likely that the group will have extensively elaborated on each idea with the STEM & BTS for enhancing students' learning achievements and transforming their science related attitudes.

Theory of modeling as an instructional strategy, modeling is an effective instructional strategy in that it allows students to observe the teacher's thought processes. Using this type of instruction, teachers engage students in imitation of particular behaviors that encourage learning. Strategy is highly teacher-directed and is among the most commonly used (Bandura, 1986). . This strategy includes methods such as lecture, didactic questioning, explicit teaching, practice and drill, and demonstrations. The direct instruction strategy is effective for providing information or developing step-by-step skills. This strategy also works well for introducing other teaching methods, or actively involving students in knowledge construction (Keesee, 2015). *However, effective teaching is not a set of generic practices, but instead is a set of context-driven decisions about teaching. Effective teachers do not use the same set of practices for every lesson . . . Instead, what effective teachers do is constantly reflect about their work, observe whether students are learning or not, and, then adjust their practice accordingly (Glickman, 1991: 6).* According to social learning theorist Albert Bandura, *"Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do. Fortunately, most human behavior is learned observationally through modeling: from observing others one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action"* (Bandura, 1977). In this research study was to develop of an innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes at the 8th grade level.

The Ministry of Education hereby authorizes implementation of the Curriculum, the provisions of which are appended to this directive. The Basic Education Core Curriculum 2008 shall replace the Basic Education Curriculum 2001. Conditions and time frame for application of the Basic Education Core Curriculum 2008 shall be as follow: for model schools for curriculum implementation and those ready for such implementation, the names of which have been announced by the Ministry of Education: in academic year 2009, the Basic Education Core Curriculum 2008 shall be applied for Grades 1-6 and Grades 7 and 10; in academic year 2010, the Basic Education Core Curriculum 2008 shall be applied for Grades 1-6, and Grades 7, 8, 10 and 11; and as of academic year 2011, the Basic Education Core Curriculum 2008 shall be applied for all grades. For schools in general: in academic year 2010, the Basic Education Core Curriculum 2008 shall be applied for Grades 1-6 and Grades 7 and 10; in academic year 2011, the Basic Education Curriculum 2008 shall be applied for Grades 1-6 and Grades 7, 8, 10 and 11; and as of academic year 2012, the Basic Education Core Curriculum 2008 shall be applied for all grades (The Minister of Education of Thailand, 2008). From the context of this basic core curriculum problem of learning management in science classroom in physics course is integrated. The problem of achievement of learning management at source has been achieved as low. The Institute the Promotion of Teaching Science and Technology (IPST) has been trying to solve the problems of learning management model with the integration of science education, this is just the beginning. Although there are eight centers, eight centers are located in different parts of the country (The Promotion of Teaching Science and Technology (IPST), 2015).

In terms of the *Learning Standards and Indicators* in science learning core, the learning standards serve as the goals in developing learners' quality, monitoring for internal quality assurance is essential, as it indicates the extent of success in achieving the quality as prescribed in the pertinent standards. Indicators specify what learners should know and be able to perform as well as their characteristics for each grade level, indicators reflect the learning standards with the eights strands with the thirteen science standards. In the context of physics contents, they are obtained at the Strand 4: Forces and Motion Standard SC4.1 and Standard SC4.2, and Strand 5: Energy Standard SC5.1. In this research, study was selected on the Strand 4: Forces and Motion Standard SC4.1 on Light and Visible Light with the instructional management between STEM education method was instructional design for secondary students at the 8th grade level in this research study.

Modified version of the short version from the original of the *Test of Science Related Attitudes* (TOSRA) that it used to assesses science-related attitudes along seven dimensions: social implications of science, normality of scientists, attitude toward scientific inquiry, adoption of scientific attitudes, enjoyment of science lessons, leisure interest in science, & career interest in science (Fraser, 1981). Fraser developed the survey to measure seven science related attitudes among secondary school students. Fraser based his design on the early work of Klopfer (1971). In his classification system, Klopfer's first scale was called "*Manifestation of favorable attitudes towards science and scientists.*" The TOSRA was used to associate student outcomes and the classroom-learning environment, particularly to add the measure of students' attitudes towards science and achievement. This research study references the extensive of Santiboon and Fisher's work that it was shown high reliability results for modifying version from the origin was all measured to assess changes in students' attitudes toward science and science related issues (Santiboon and Fisher, 2005) for developing an innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes at the 8th grade level.

The driving force of 21st Century learning is the focus on preparing our young students to be successful in today's world. And because the world is changing so rapidly in our digital age, the needs of our students are progressing as well. the tenets of 21st Century learning and find out how you can enhance your teaching methods to best serve today's young learners, check out our article on the topic: "*What is 21st Century learning? How a master's degree can enhance the effectiveness of your classroom* (Scherman, 2016). This present study was checked by education experts maintain that one of the most effective ways to make a lesson stick is to involve the students directly. This is why research team often sees student skits or mock trials. These hands-on activities can help transform a lesson into an experience. Based on the above-mentioned concept, the researchers was developed an innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes in science class. As a result, students learning achievement with the instructional management strategies combined with the STEM education and brainstorming techniques were designed of the innovative lesson plan. Thus, the model of STEM Education teaching and learning was integrated into the model of science experiment of the lower secondary students at the 8th grade level at Khatiyawonhsa School under the Roi-Et Secondary Educational Service Area Office 27 is the context of research limitation in this study.

2. Research Methodology

Generally, the process by which instruction is improved through the analysis of learning needs and systematic development of learning experiences; the instructional designers often use technology and multimedia as tools to enhance instruction. It is designed to provide information about *instructional design* principles and how they relate to teaching and learning. Instructional design (or instructional systems design), is the analysis of learning needs and systematic development of instruction. Effective instructional designers are also familiar with a wide range of educational technology that can be used for delivering learning experiences. Instructional design models provide a method, that if followed will facilitate the transfer of knowledge, skills and attitude to the learner. Presenting content in a simple, meaningful way is the art of good instructional design. Researcher team was increasingly seeing an emphasis on innovative instructional strategies combined with the STEM education and brainstorming techniques integration in secondary school classrooms such that students would learn and apply relevant math and science content while simultaneously developing engineering habits of mind. However, research in both science education and engineering education suggests that this goal of truly integrating STEM is rife with challenges. To compare between students' learning achievements were assessed, students' performances of their attitudes towards science were associated. The research methodology was following as:

3. Research Objectives

1. To evaluate of an innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes at the 8^{th} grade level.
2. To develop an innovative instructional lesson plan based on the strategies combined with the STEM education and brainstorming techniques for secondary students at the 8^{th} grade level in science classes on Light and Visible Light issue with the processing and performance resulting effective determinant criteria at the level of 75/75.
3. To compare between students' learning achievements and their science attitudes to their pre and post assessing designs toward their learning management according to the model of learning management in strategies combined with the STEM education and brainstorming techniques on Light and Visible Light issue in science class.
4. To analyze of the associations between students' learning achievements of their posttest assessment and their attitudes toward science with an innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes at the 8^{th} grade level.

4. Research Procedures

To develop the innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes at the 8^{th} grade level. Research team has been designed in five steps of research procedures that followed as:

Step I: Created the Lesson Plan of the Innovative Instructional Strategies Combined with the STEM & BTS

The innovative instructional strategies combined with the STEM education and brainstorming techniques (STEM & BTS) was created and designed on 1 lesson plan of 9 units for learning management in 15 hours that composed of the content, such as: the composition of the eye, the subject of the human eye image, the brightness of light to the human eye, the brightness of the light of life, color of light, reflection and refraction, get to know the STEM activities, STEM integration activities (lit up in secret fleeting), and students' presentation of STEM and brainstorming techniques' activities with the definition of the content, analysis of curriculum course description determine the purpose of learning, and creating a learning management plan.

Step II: Creating the Steps of Learning Activities with the STEM & BTS

The processes of implementing activities according to the learning management plan that focuses on teaching and learning activities with the STEM & BTS composed as: Select Central Standards, Align with a Problem, Support Central Standards with Supplemental Standards, Instruct STEM Standards, Engage Student Participation, Troubleshoot the Designs, Evaluate the Designs, and Present Completed Projects steps.

Step III: the Quality of an Innovative Instructional Strategies of the STEM & BTS was Checked

Using the innovative instructional strategies combined with the STEM & BTS was checked by the advisors and the professional experts with the *Index of Item Objective Congruence* (IOC*)*. Researcher team was selected the STEM & BTS that it had the high quality of appropriability, only.

Step IV: Created the Learning Achievement Test (LAT)

Investigations of curriculum, content, objectives, expected learning outcomes, and lesson plans were created the *Learning Achievement Test* (LAT) were assessed students' learning achievements of their pretest and posttest designs. The LAT was tried out with another sample group and proved by the professional experts. The 50-item *Leaning Achievement Test* (LAT) on Light and Visible Light Issue was created by the researcher team of 50 optional items in 4 multiple choice options was assessed in the fourth step of research procedures.

Step V: Selected the TOSRA for Assessing Students' Perceptions of their Attitudes

The original of the *Test of Science-Related Attitudes* (TOSRA) was assessed science-related attitudes along seven dimensions: social implications of science, normality of scientists, attitude toward scientific inquiry, adoption of scientific attitudes, enjoyment of science lessons, leisure interest in science, & career interest in science and obtained of 70 items (Fraser, 1981). The terms "attitude" is very common and popular in daily life. Everyone has given it its own meanings, concepts and definitions. An aim of this study was to explore the psychometric attitudes of the *Test of Science-Related Attitude* (TOSRA) to adapt to the Thai version that it obtained of 8 items (Santiboon and Fisher, 2005) was assessed students' perceptions of their attitudes toward science in physics classes in the five step of research methodology.

4.1 Using the Popular Instructional Method in 21st-Century: STEM Education

Exactly, with clear definitions of both STEM education and STEM literacy, the authors argue that STEM in itself is not a curriculum, but rather a way of organizing and delivering instruction by weaving the four disciplines together in intentional ways. Rather than adding two new subjects to the curriculum, the engineering and technology practices can instead be blended into existing mathematics and science lessons in ways that engage students and help them master 21st century skills. STEM Innovative Lesson Plans of the essentials was built how to begin the STEM integration journey with: five guiding principles for effective STEM instruction, science classes were responded of what these principles look like in action of students' perceptions, sample activities that put all four STEM fields into practice, and lesson planning templates for STEM units were assessed by the professional expert educators were checked of their efficiency quality in the third step of research methodology.

4.2 Combination of the STEM Education and Brainstorming Techniques to Enhance Students' Learning Achievements and Transforming their Science Related Attitudes

The innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes at the 8th grade level were instructed designs. A good deal of research refutes Osborn's claim that group brainstorming could generate more ideas than individuals working alone. Overwhelmingly, groups brainstorming together produce fewer ideas than individuals working separately. This process involves brainstorming the *questions*, rather than trying to come up with immediate answers and short term solutions in 6 learning activities, namely; Fishbone chart, Graph, Checklist, Pareto chart, Fishbone chart, and 7 QC Tools. In disposition of the combination of the STEM education and brainstorming technique instructional methods, teachers and students convey personal values or ways of thinking. Although teachers must be careful not to offend and to be inclusive when modeling dispositions, this type of modeling is important for facilitating the development of character and community. Teachers can model desired personal characteristics by acting with integrity and empathy and by setting high expectations. Teachers who are creative, diligent, well-prepared, and organized model the kinds of strategies needed to succeed in the workforce. Modified of the thinking of Osborn that brainstorming should address a specific question was detailed.

4.3 Sample Size

This research study was administered in the lower secondary educational school students who sat at the 8th grade level which sample size of 25 students in science class in the second semester of academic year 2016 at Khatiyawongsa School under the Roi-Et Secondary Educational Service Area Office 27 with the purposive sampling technique.

4.4 Data Analysis

Using the foundational statistic with percentage, mean, standard deviation for analyzing the basically data was examined. The validity and reliability of research instruments were assessed with internal consistency Cronbach alpha reliability and discriminant validity. Statistically significant was differentiated data to compare with the independent variable t-test and ANOVA results (eta^2). Associations between students' learning achievements of their posttest outcomes and their attitudes toward science in science classroom environments with simple and multiple correlations, standardized regression weight abilities and the coefficient predictive value (R^2) were used.

5. Results

The purposes of the development of the innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes at the 8th grade level were investigated with the instructional lesson plan, students' learning achievements and their attitudes toward science of their pretest and posttest designs, associations between students' learning achievements and their attitudes were reported.

5.1 Validity and Reliability of Research Instruments

5.1.1 The IOC Value of the STEM & BTS Innovative Instructional Lesson Plan

The STEM education combined with the brainstorming techniques innovative instructional lesson plan was created learning plan offers the counselor to verify the content validity for students' learning activities, teaching materials, and evaluation in the learning management plan was corrected as suggested by the advisors and the 3-professional expert educators were reviewed and assessed the validity of content, purpose learning with the IOC value (*Index of Item Objective Congruence*) was 0.88, it appeared that the research plan developed by the researcher team, students' responses of their learning activities were at the high level ($\overline{X}$ = 7.63 , SD = 0.60), the relationships of six learning activities with F-test was significant at level of 0.001.

5.1.2 Validity of the LAT

To assess students' learning achievements of their pretest-posttest designs were an expansion of the posttest only design with the target groups, one of the simplest methods of testing the effectiveness of an intervention. In this design, which was given the treatment and the results were gathered at the end with statistical analysis that can then determine the intervention had a significant effect. The 50-item *Leaning Achievement Test* (LAT) was averaged of 7.51 - 8.50 means that the brainstorming activities of students are at a high level.

5.1.3 Validity of the TOSRA

The *Test of Science-Related Attitudes* (TOSRA) questionnaire was selected to use with the aim of investigating any possible relationships with the instructional management between the STEM & BTS for developing students' attitudes toward science. The TOSRA consists of eight items and the five response alternatives are: *Almost Never* (1), *Seldom* (2), *Sometimes* (3), *Often* (4) and *Very Often* (5). The minimum score as 8 and maximum score as 40, and the average mean score range from 1.00 to 5.00 was indicated. The internal consistency (Cronbach alpha coefficient) was obtained for the sample in this present study as indices of scale reliability is 0.79.

5.2 The Effectiveness of the STEM Education Innovative Instructional Lesson Plan

To analyze the effectiveness of the innovative instructional lesson plans based on the model of learning management in a STEM & BTS of secondary students at the 8th grade level in science classes with the processing and performance resulting effectiveness at 75/75 criteria. Table 1 reports of the effectiveness of the innovative instructional lesson plan.

Table 1: Score Total, Mean, Standard Deviation, and Percentage for the Effectiveness Innovative Instructional Lesson Plans for the STEM & BTS

Efficiency Type	Total Score	$\overline{X}$	S.D.	Percentage
Efficiency Performance Processes (E1)	140	108.79	3.28	77.64
Efficiency Performance Results (E2)	50	39.24	1.74	78.48
The Lessoning Effectiveness (E1/E2) = 77.64/78.48				

Table 1 shows the result for the effectiveness of the innovative instructional lesson plans based on the model of learning management in the STEM & BTS STEM. Effectiveness of lessons during the learning process (E1) reveals of 77.64 and the performance effectiveness (E2) indicate that of 78.48, so the lessoning effectiveness (E1/E2) evidences of 77.64/78.48 over the threshold setting is 75/75.

5.3 Comparisons between Students' Learning Achievements of their Pretest and Posttest Assessments with the Innovative Instructional the STEM & BTS

To compare between students' learning achievements of their pretest and posttest assessments with the innovative instructional lesson plans based on the model of learning management in the STEM & BTS of secondary students at the 8th grade level in science laboratory environment classes with the 50-item *Learning Achievement Test* (LAT) was assessed. Table 2 reports the statistically significance of the difference between students' learning outcomes of their pretest and posttest assessments. Using paired comparisons between different assessments of the same LAT as reports in Table 2.

Table 2: Average Mean, Standard Deviation, Mean Difference for the PPAT

Assessing Test	Total score ($\overline{X}$ =50)	Standard Deviation	Mean Diff.	*t*-Value	ANOVA (eta^2)
Pretest	21.56	3.01	17.68	35.51***	0.50***
Posttest	39.24	1.74			

*N = 25, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

Table 2 reported on students' learning achievements, the district would need assessments at two points in time: before learning begins and at the end of the science course. These assessments can be thought of as pre-tests and post-tests. The average mean scores of pretest of 21.56 and posttest revealed as 39.24. In most case, the standard deviation for the pretest as 3.01 and for the posttest as 1.74, and the mean difference between pre-tests and post-tests of 17.68 were compared. It also provides support the learning management in the STEM & BTS that teacher needed to take differences into consideration when planning and designing science curriculum in the science laboratory were assessed with the independent t-test and ANOVA (eta^2) significantly ($\rho < 0.001$).

5.4 Comparisons between Students' Perceptions of their Attitudes toward Science to their Pre- and Post-TOSRA

To compare between students' perceptions of their attitudes toward science to their pre- and post-TOSRA of secondary students at the 8th grade level in science laboratory environment classes with the 8-item *Test of Science-Related Attitudes* (TOSRA) was assessed. Table 4 reports the statistically significance of the difference between students' learning outcomes of their pretest and posttest assessments. Using paired comparisons between different assessments of the same TOSRA as reports in Table 3.

Table 3: Average Mean, Standard Deviation, Mean Difference, t-test and ANOVA (eta^2) for the TOSRA

Assessing Test	**Total score** ($\overline{X}$ =5)	**Standard Deviation**	**Mean Diff.**	***t*-Value**	**ANOVA (eta^2)**
Pretest	3.79	0.54	0.60	6.07**	0.34**
Posttest	4.39	0.38			

*N = 25, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

Table 3 reported on students' perceptions of their attitudes toward science to their pre- and post-TOSRA of secondary students at the 8th grade level in science laboratory environment classes with the 8-item *Test of Science-Related Attitudes* (TOSRA). The average mean scores of pre-attitude of 3.79 and post-attitude revealed as 4.39. In most case, the standard deviation for the pre-attitude as 0.54 and for the post-attitude as 0.38, and the mean difference between pre- and post-attitudes of 0.60 were compared. It also provides support the learning management in the TOSRA that teacher needed to take differences into consideration when planning and designing science curriculum in the science were assessed with the independent t-test and ANOVA (eta^2) significantly ($\rho < 0.01$).

5.5 Associations between Students' Learning Achievements of their Posttest Assessment and their Post-TOSRA

Students' learning achievements of their posttest assessment with the LAT to their perceptions of their attitudes toward science (TOSRA) with the innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes.

Table 4: Associations between Students' Pretest and Posttest Achievements for the Previous CTAT in Term of Simple Correlation (r), Multiple Correlations (R) and Standardized Regression Coefficient (β)

Variables	Mean ($\overline{X}$)	S.D.	Simple Correlation (r)	Standardized Regression Validity (β)	Multiple Correlation (R)	Efficiency Predictive Value (R^2)
Posttest Assessment (LAT)	3.92	0.17	0.23**	0.21**	0.7078**	0.5010**
Post-Attitude Assessment (TOSRA)	4.65	0.13				

*N = 25, *ρ < 0.05, **ρ < 0.01, ***ρ < 0.001*

Table 4 reports the associations between students' learning outcomes of their posttest assessments to their post-attitude toward science. Simple correlation and multiple regressions analyses were conducted to examine whether associations exists between students' learning achievements of their posttest assessment to their perceptions of their attitudes toward science with the innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes.

Table 4 shows the correlations between posttest assessment (LAT) and the TOSRA were relative significantly, when using a simple correlation analysis (r) and standardized regression validity (β). The multiple correlations (R) was 0.7078 and the predictive efficiency (R^2) value indicated that 50% of the variances in students' students' learning outcomes to their science class was attributable to their post attitudes toward science in their science classroom environments. The coefficient of determination, denoted R^2 and pronounced "R squared", is a number that indicates the proportion of the variance in the dependent variable (LAT) that is predictable from the independent variable (TOSRA). It provides a measure of how well observed outcomes are replicated by the instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes. Based on the proportion of total variation of students' learning outcomes explained by the STEM & BTS instructional model was associated and the efficient predictive determinant (R^2) values are reported which show statistically significant are correlations (p<.05) for the posttest assessments to their attitudes toward science, relatively.

6. Conclusions

Development of the innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes at the 8^{th} grade level were investigated. This research study was designed to investigate and examine of the effects of the activity-based on learning achievements, and environmental perceptions of students' attitudes toward science in science class of students at the 8^{th} grade level for the target group that was the upper secondary educational school students who sat at the 8^{th} grade level which sample size of 25 students in science class in the second semester of academic year 2016 at Khatayawongsa School, under the Secondary Educational Service Area Office 27, Roi-Et Province in Thailand. The context of the content that it composes of the Light and Visible Light Issue, and the Law of Conservation of Energy from the Strand 4: Forces and Motion that focused on the Standard SC4.2 from the Basic Education Core Curriculum B.E. 2551 was aimed at the full development of learners in all respects - morality, wisdom, happiness, and potentiality for further education was selected of the context of the strand and learning standard in science learning area in terms of students' perceptions of their learning environment and their creative thinking ability toward science.

Pretest-Posttest designs for assessing students' learning achievements was defined factors that impact a student's ability to achieve and explains what research shows about successful student achievement with the 9-sub lesson plans. The preferred method to compare participant groups and measure the degree of change occurring as a result of treatments or interventions were assessed. Pretest-posttest designs are an expansion of the posttest only design with nonequivalent groups, one of the simplest methods of testing the effectiveness of an intervention. In this design, which uses two groups, one group is given the treatment and the results are gathered at the end. The student group receives no treatment, over the same period of time, but undergoes exactly the same tests. Statistical analysis can then determine if the intervention had a significant effect. The result for the effectiveness of the innovative instructional lesson plans based on the model of learning management in a STEM Education Method was designed. Effectiveness of lessons during the learning process (E1) reveals of 77.64 and the performance effectiveness (E2) indicate that of 78.48, so the lessoning effectiveness (E1/E2) evidences of 77.64/78.48 over the threshold setting is 75/75.

Focused on the comparisons compare between students' learning achievements of their pretest and posttest assessments with the innovative instructional strategies combined with the STEM education and brainstorming techniques of secondary students at the 8^{th} grade level in science environment classes were assessed. Students' learning achievements of their pretest and posttest assessments with the 50-item LAT to their innovative instructional STEM education strategy combined with the brainstorming techniques, students' outcomes of average mean scores with their posttest ($\overline{X}$ = 39.24, SD = 0.1.74) was higher than pretest ($\overline{X}$ = 21.56, SD = 3.01), and statistically significant was differentiated at the level of .001 (t = 35.51, eta^2 = 0.50).

Comparisons between students' perceptions of their attitudes toward science to their pre- and post-TOSRA of secondary students at the 8th grade level in science laboratory environment classes with the 8-item *Test of Science-Related Attitudes* (TOSRA) was assessed. The statistically significance of the difference between students' learning outcomes of their pretest and posttest assessments were paired comparisons between different assessments of the same TOSRA. Students' perceptions of their attitudes toward science to their pre- and post-TOSRA of secondary students at the 8th grade level in science laboratory environment classes with the 8-item *Test of Science-Related Attitudes* (TOSRA). The average mean scores of pre-attitude of 3.79 and post-attitude revealed as 4.39. In most case, the standard deviation for the pre-attitude as 0.54 and for the post-attitude as 0.38, and the mean difference between pre- and post-attitudes of 0.60 were compared. It also provides support the learning management in the TOSRA that teacher needed to take differences into consideration when planning and designing science curriculum in the science were assessed with the independent t-test and ANOVA (eta^2) significantly ($\rho < 0.01$).

Associations between students' learning outcomes of their posttest assessments to their post-attitude toward science were assessed. Simple correlation and multiple regressions analyses were conducted to examine whether associations exists between students' learning achievements of their posttest assessment to their perceptions of their attitudes toward science with the innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes. The correlations between posttest assessment (LAT) and the TOSRA were relative significantly, when using a simple correlation analysis (r) and standardized regression validity (β). The multiple correlations (R) was 0.7078 and the predictive efficiency (R^2) value indicated that 50% of the variances in students' students' learning outcomes to their science class was attributable to their post attitudes toward science in their science classroom environments indicated the proportion of the variance in the dependent variable (LAT) that is predictable from the independent variable (TOSRA). It provides a measure of how well observed outcomes are replicated by the instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes. Based on the proportion of total variation of students' learning outcomes explained by the STEM & BTS instructional model was associated and the efficient predictive determinant (R^2)

values are reported which show statistically significant are correlations (p<.05) for the posttest assessments to their attitudes toward science, relatively. Based on these findings, suggestions that development of an innovative instructional strategies combined with the STEM education and brainstorming techniques for enhancing students' learning achievements and transforming their science related attitudes at the 8th grade level are provided.

7. Discussions

The results of this research study have probably got some ideas of how experiments should be run. Researchers are always making things super complicated. The reason ran a pretest-posttest experiment is to see the thing that to be able to looking at, has caused a change in the participants. Since student is being manipulated in the same way, any changes and see across the group of participants is likely from the manipulation. This means teachers test them before doing the experiment, then teachers run their experimental manipulation, and then teachers test them again to see if there are any changes. This is the research designed for assessing students' assessments of their pretest and posttest techniques were compared.

A research purpose was to assess students' learning achievements and transforming their science related attitudes enhancing their learning achievements through the instructional approaching management with the innovative instructional STEM education strategy combined with the brainstorming techniques of secondary students at the 8th grade level. One way was to find the efficiency of teaching innovation based on the E1/E2 criteria set. The innovation is complete all whole of steps. The average percentage score obtained from the whole group's learning process is close to the average score obtained from the post-test. It should not have a value difference of more than **5**%, generally. In this recent study, the innovative instructional lesson plans based on the model of learning management for the innovative instructional STEM education strategy combined with the brainstorming techniques. Effectiveness of lessons during the learning process (E1) and the performance effectiveness (E2) revealed of 77.64/78.48 over the threshold setting is 75/75. The results shows the finding of the E1/E2 indicates that of less than a value difference of **5**% from the set of standardized criteria of 75/75, significantly.

In previous sets of notes in this series research team analyzed a pretest-posttest designs using blocking, matching, and analysis of covariance procedures. Those procedures were used to analyze the differences in posttest scores after any pretest score differences were "held constant". The interaction is a comparison of the differences between the posttest and pretest scores in each treatment group. In this set of notes we will take a different approach and look at the *change* from the pretest and posttest scores. The data that we displayed in the analysis of covariance notes are redisplayed here using the pretest and posttest means within each treatment condition. The 50-item *Learning Achievement Test* (LAT) question of interest is whether the improvement in scores from pretest to posttest is greater for the experimental group with the learning activities of the innovative instructional strategies combined with the STEM education and brainstorming techniques in science class. It also provides support the learning management in the instructional strategies combined with the STEM education and brainstorming techniques that teacher needed to take differences into consideration when planning and designing science curriculum class were assessed with the independent *t*-test and ANOVA (eta^2) significantly ($\rho<0.001$) from the STEM & BTS instructional methods, significantly.

The main purposes of this article are to outline a convenient questionnaire designed to assess students' learning achievements of their posttest outcomes and their perceptions of their attitudes towards science. The article describes various forms of the 50-item *Learning Achievement Test* (LAT) were assessed of their learning outcomes and the 8-item *Test Of Science-Related Attitude* (TOSRA). These instruments are validated and reliability for using the future in this research study and report its use in this research; and examines associations between students' learning of their posttest outcomes and their perceptions of their attitudes towards science, as assessed by the LAT and student attitude with the TOSRA. This study has confirmed the reliability and validity of the research instruments; the LAT and TOSRA when used in science class.

Using the foundational statistic with percentage, mean, standard deviation for analyzing the basically data was examined. The validity and reliability of research instruments were assessed with internal consistency Cronbach alpha reliability. Statistically significant was differentiated data to compare with the independent variable t-test and ANOVA results (eta^2). Associations between students' learning achievements of their posttest outcomes and their perceptions to their attitudes toward science with simple and multiple correlations, standardized regression weight abilities and the coefficient predictive determinant value (R^2) were analyzed of associations between students' learning achievements outcomes of their posttest assessments (LAT) to their science attitudes (TOSRA) were assessed. The coefficient predictive values (R^2) indicated that the relationships between students' responses of the LAT and their TOSRA significant at the level of .05, and the R^2 indicated that of these values are less than 50% of the LAT and TOSRA for the assessments are according to the international previous research studies.

References

1. Bandura, A. (1977). *Social Learning Theory*. New York: General Learning Press. p. 22.
2. Bandura, A. (1986). *Social foundations of thought and action: A social cognitive*. Englewood Cliffs, NJ: Prentice Hall.
3. Central of Research on Teaching and Learning. (2015). *Methods of evaluating teaching*. Retrieved from http://www.crlt.umich.edu/resources/evaluation-teaching/methods.
4. Damodharan, V. S. (2014*). Innovative methods of teaching*. Retrieved from http://math.arizona.edu/~atpmena/conference/proceedings/DamodharanInnovative_Methods.pdf
5. Fraser, B. J. (1981). *TOSRA: Test of science-related attitudes handbook*. Hawthorn, Victoria: Australian Council for Educational Research.
6. Furnham, A., & Yazdanpanahi, T. (1995). Personality differences and group versus individual brainstorming. *Personality and Individual Differences*, *19*, pp. 73-80.
7. Glickman, C. (1991). Pretending not to know what we know. Educational Leadership, 48(8), 4-10.
8. Keesee, G. S. (2015). *Instructional approaches: Teaching and learning resources.* Retrieved from http://teachinglearningresources.pbworks.com/w/page/19919560/InstructionalApproaches.
9. Knowles, M. (1984). The adult learner: A neglected species (3rd Ed.). Houston, TX: Gulf Publishing.
10. Klopfer, L.E. (1971). *Evaluation of learning in science*. In B.S. Bloom, J.T. Hastings, and G.F. Madaus (Eds), Handbook on Summative and formative Evaluation of Student Learning. New York: McGraw-Hill.
11. Mayer, R. E. (1992). Cognition and instruction: Their historic meeting within educational psychology. *Journal of Educational Psychology*. *84* (4): pp. 405–412.
12. *Merrill, M. D.; Drake, L.; Lacy, M. J.; Pratt, J. (1996). Reclaiming instructional design (PDF). Educational Technology. 36 (5): pp. 5–7.*
13. New Jersey Technology and Engineering Educator Association. (2015). *STEM education resource.* Retrieved from http://njteeastem.weebly.com/stem-resources.html
14. Osborn, A.F. (1963) *Applied imagination: Principles and procedures of creative problem solving* (Third Revised Edition). New York, NY: Charles Scribner's Sons.

15. Santiboon, T. & Fisher D. L. (2005). *Learning environments and teacher-student interactions in physics classes in Thailand.* Proceedings of the Fourth International Conference on Physics, Mathematics and Technology Education Sustainable Communities and Sustainable Environments: Envisioning a Role for Physics, Mathematics and Technology Education, Victoria, Vancouver, Canada.
16. Scherman, J. (2016). *4 innovative teaching strategies for difficult lesson plans.* Retrieved from https://www.css.edu/the-sentinel-blog/innovative-teaching-strategies-for-difficult-lesson-plans.html
17. The Minister of Education of Thailand. (2008). *The Basic Education Core Curriculum B.E. 2551 (A.D. 2008)*. Retrieved from website: http://www.skn.ac.th/kan2551.htm
18. The Minister of Education of Thailand. (2012*). Education in Thailand*. Retrieved from website: https://en.wikipedia.org/wiki/Education_in_Thailand
19. The Promotion of Teaching Science and Technology (IPST). (2015). *The Basic Education Core Curriculum B.E. 2551 (A.D. 2008) (Draft)*. Retrieved from website: http://eng.ipst.ac.th/index.php/component/content/category/9-about-us